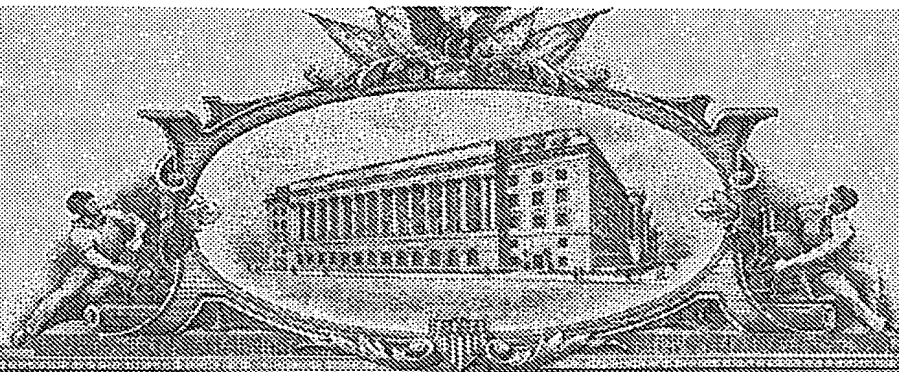1223954

THE UNITED STATES OF AMERICA

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UNITED STATES DEPARTMENT OF COMMERCE

United States Patent and Trademark Office

September 10, 2004

THIS IS TO CERTIFY THAT ANNEXED HERETO IS A TRUE COPY FROM THE RECORDS OF THE UNITED STATES PATENT AND TRADEMARK OFFICE OF THOSE PAPERS OF THE BELOW IDENTIFIED PATENT APPLICATION THAT MET THE REQUIREMENTS TO BE GRANTED A FILING DATE.

APPLICATION NUMBER: *60/496,426*
FILING DATE: *August 20, 2003*
RELATED PCT APPLICATION NUMBER: *PCT/US04/25366*

Certified by

Jon W Dudas

Acting Under Secretary of Commerce
for Intellectual Property
and Acting Director of the U.S.
Patent and Trademark Office

Please type a plus sign (+) inside this box ➔ ⊞

17497 U.S. PTO
60/496426
08/20/03

PROVISIONAL APPLICATION FOR PATENT COVER SHEET

This is a request for filing a PROVISIONAL APPLICATION FOR PATENT under 37 CFR 1.53 (c).

Express Mail Label No. EL995079232US

INVENTOR(S)

Given Name (first and middle [if any])	Family Name or Surname	Residence (City and either State or Foreign Country)
Jill MacDonald	Boyce	Manalapan, New Jersey
Cristina	Gomila	Princeton, New Jersey

☒ Additional inventors are being named on the 1 separately numbered sheets attached hereto

TITLE OF THE INVENTION (280 characters max)

VIDEO COMFORT NOISE

CORRESPONDENCE ADDRESS

Direct all correspondence to:

☐ Customer Number

OR

Type Customer Number here

➔ Place Customer Number Bar Code Label here

☒ Firm or Individual Name	JOSEPH S. TRIPOLI, THOMSON LICENSING INC.
Address	PATENT OPERATIONS.
Address	P. O. BOX 5312

City	PRINCETON	State	NJ	ZIP	08543-5312
Country	USA	Telephone	609-734-6834	Fax	609-734-6888

ENCLOSED APPLICATION PARTS (check all that apply)

☒ Specification *Number of Pages* | 5 | ☐ CD(s), Number | |

☐ Drawing(s) *Number of Sheets* | | ☐ Other (specify) | |

☐ Application Data Sheet. See 37 CFR 1.76

METHOD OF PAYMENT OF FILING FEES FOR THIS PROVISIONAL APPLICATION FOR PATENT (check one)

☐ Applicant claims small entity status. See 37 CFR 1.27.

☐ A check or money order is enclosed to cover the filing fees

FILING FEE AMOUNT ($)

☒ The Commissioner is hereby authorized to charge filing fees or credit any overpayment to Deposit Account Number: 07-0832

160

☐ Payment by credit card. Form PTO-2038 is attached.

The invention was made by an agency of the United States Government or under a contract with an agency of the United States Government.

☒ No.
☐ Yes, the name of the U.S. Government agency and the Government contract number are: _____.

Respectfully submitted,
SIGNATURE _____

TYPED or PRINTED NAME   Robert B. Levy

TELEPHONE 609 734-6820

Date 8/20/03

REGISTRATION NO. (if appropriate)   28,234

Docket Number: PU030249

USE ONLY FOR FILING A PROVISIONAL APPLICATION FOR PATENT

PROVISIONAL APPLICATION COVER SHEET
Additional Page

	Docket Number	PU030249	Type a plus sign (+) inside this box →	+

INVENTOR(S)/APPLICANT(S)		
Given Name (first and middle [if any])	Family or Surname	Residence (City and either State or Foreign Country)
Jeffrey Allen	Cooper	Rocky Hill, New Jersey

Number 2 of 2

WARNING: Information on this form may become public. Credit card information should not be included on this form. Provide credit card information and authorization on PTO-2038.

FEE TRANSMITTAL
for FY 2003

Effective 01/01/2003. Patent fees are subject to annual revision.

☐ Applicant claims small entity status. See 37 CFR 1.27

TOTAL AMOUNT OF PAYMENT | ($) 160

Complete if Known	
Application Number	
Filing Date	
First Named Inventor	Jill MacDonald Boyce
Examiner Name	
Group / Art Unit	
Attorney Docket No.	PU030249

METHOD OF PAYMENT (check all that apply)

☐ Check ☐ Credit card ☐ Money Order ☐ Other ☐ None

☒ Deposit Account:

Deposit Account Number: 07-0832

Deposit Account Name: Thomson Licensing Inc.

The Commissioner is authorized to: *(check all that apply)*
☒ Charge fee(s) indicated below ☒ Credit any overpayments
☒ Charge any additional fee(s) during the pendency of this application
☐ Charge fee(s) indicated below, except for the filing fee
to the above-identified deposit account.

FEE CALCULATION

1. BASIC FILING FEE

Large Entity		Small Entity			
Fee Code	Fee ($)	Fee Code	Fee ($)	Fee Description	Fee Paid
1001	750	2001	375	Utility filing fee	
1002	330	2002	165	Design filing fee	
1003	520	2003	260	Plant filing fee	
1004	750	2004	375	Reissue filing fee	
1005	160	2005	80	Provisional filing fee	160

SUBTOTAL (1) | ($) 160

2. EXTRA CLAIM FEES

	Extra Claims	Fee from below	Fee Paid
Total Claims	-20** = 0	X	= 0
Independent Claims	-3** = 0	X	= 0
Multiple Dependent		X	= 0

Large Entity		Small Entity			
Fee Code	Fee ($)	Fee Code	Fee ($)	Fee Description	
1202	18	2202	9	Claims in excess of 20	
1201	84	2201	42	Independent claims in excess of 3	
1203	280	2203	140	Multiple dependent claim, if not paid	
1204	84	2204	42	** Reissue independent claims over original patent	
1205	18	2205	9	** Reissue claims in excess of 20 and over original patent	

SUBTOTAL (2) | ($) 0

**or number previously paid, if greater; For Reissues, see above

FEE CALCULATION (continued)

3. ADDITIONAL FEES

Large Entity		Small Entity			
Fee Code	Fee ($)	Fee Code	Fee ($)	Fee Description	Fee Paid
1051	130	2051	65	Surcharge - late filing fee or oath	
1052	50	2052	25	Surcharge - late provisional filing fee or cover sheet.	
1053	130	1053	130	Non-English specification	
1812	2,520	1812	2,520	For filing a request for reexamination	
1804	920*	1804	920*	Requesting publication of SIR prior to Examiner action	
1805	1,840*	1805	1,840*	Requesting publication of SIR after Examiner action	
1251	110	2251	55	Extension for reply within first month	
1252	410	2252	205	Extension for reply within second month	
1253	930	2253	465	Extension for reply within third month	
1254	1,450	2254	725	Extension for reply within fourth month	
1255	1,970	2255	985	Extension for reply within fifth month	
1401	320	2401	160	Notice of Appeal	
1402	320	2402	160	Filing a brief in support of an appeal	
1403	280	2403	140	Request for oral hearing	
1451	1,510	1451	1,510	Petition to institute a public use proceeding	
1452	110	2452	55	Petition to revive – unavoidable	
1453	1,300	2453	650	Petition to revive – unintentional	
1501	1,300	2501	650	Utility issue fee (or reissue)	
1502	470	2502	235	Design issue fee	
1503	630	2503	315	Plant issue fee	
1460	130	1460	130	Petitions to the Commissioner	
1807	50	1807	50	Processing fee under 37 CFR 1.17 (q)	
1806	180	1806	180	Submission of Information Disclosure Stmt	
8021	40	8021	40	Recording each patent assignment per property (times number of properties)	
1809	750	2809	375	Filing a submission after final rejection (37 CFR § 1.129(a))	
1810	750	2810	375	For each additional invention to be examined (37 CFR § 1.129(b))	
1801	750	2801	375	Request for Continued Examination (RCE)	
1802	900	1802	900	Request for expedited examination of a design application	

Other fee (specify) _____

*Reduced by Basic Filing Fee Paid   SUBTOTAL (3) | ($) 0

SUBMITTED BY

	Complete (if applicable)				
Name (Print/Type)	Robert B. Levy	Registration No. Attorney/Agent)	28,234	Telephone	609-734-6820
Signature				Date	August 20, 2003

A. Brief summary of the inventi n

Video compression at low bitrates tends to cause visible artifacts that are noticeable to a viewer. The human visual system causes some types of artifacts to be more noticeable and objectionable than others. Addition of random noise can reduce the noticeability of compression artifacts, but large frame-to-frame differences created by random noise addition are themselves noticeable and objectionable. In this invention, temporal correlation is used in the creation of the additive comfort noise pattern to reduce the amount of frame-to-frame differences.

B. Keywords: list Keywords or combinations of keywords to guide patent and literature searches. Underline the most important keywords.

H.264, JVT, MPEG AVC
dither
comfort noise

C. Brief discussion of the problem solved by the invention.

Video compression at low bitrates tends to cause visible artifacts that are noticeable to a viewer. The human visual system causes some types of artifacts to be more noticeable and objectionable than others. Blockiness and structured noise patterns are common artifacts in block-based image and video compression techniques. Addition of random noise can reduce the noticeability of compression artifacts, but large frame-to-frame differences created by random noise addition are themselves noticeable and objectionable.

D. Discussion of how you or others have implemented similar things in the past, including the manner in which others have attempted to solve the problem. Point out disadvantages and weaknesses in previous practice. Include literature references where available.

It is well known that addition of a dither signal can reduce human sensitivity to image artifacts, for example to hid contouring and blocking artifacts. In [1], a random noise dither based on film grain is added to an image to hide block effects, with the rationale "random error is more forgiving than the structure, or correlated error."

It has also been previously proposed that a dither signal be added to video sequences to hide compression artifacts. In [2], it was proposed that a random noise dither be added in the video encoding and decoding process in the in loop deblocking filter for the JVT video coding standard [3]. The amount of dither to be added depended on the position of a pixel with respect to a block edge.

The term "comfort noise" is used in audio compression to indicate noise pattern generated at the receiver end, to avoid total silence that is uncomfortable to a listener.

It was proposed in [4] that random noise be added as a postprocess to video decoding, for use as comfort noise. The amount of noise added depends on the quantization parameter and the amount of noise added to spatially neighboring pixels.

[1] S. Yang, Y. Hu, "Blocking Effect Removal Using Regularization and Dithering", ICIP 1998, p. 415-419.

[2] G. Conkin, N. Gokhale, JVT-C-56, "Dithering 5-tap Filter for Inloop Deblocking," ftp://ftp.imtc-files.org/jvt-experts/2002_-5_Fairfax/JVT-C056.doc

[3] T. Wiegand, JVT Study of Final Committee Draft, Dec 5-13, 2002, ftp://ftp.imtc-files.org/jvt-experts/2002_12_Awaji/JVT-F100d1ncm.zip

[4] G. Bjontegaard, "Addition of 'comfort noise' as post processing", ITU-T SG 16 Q15-B-15.

E. Description of the invention, including one or more practical embodiments of the invention in sufficient detail to allow one with ordinary skill in the art to practice the invention. Include schematic(s), flow chart(s) and/or figures to clarify operation of the invention. Point out important features and items you believe to be new. State advantages of the invention and sacrifices, if any, made to achieve these advantages. Describe any experiments conducted and the results of those experiments.

A dither signal containing random noise is added to the pictures in a video sequence, after video compression decoding, to improve the subjective video quality. Figure 1 shows a receiver end system, which includes a video decoder and a comfort noise generator. The generated noise is added to the decoded pictures prior to display. The addition of the comfort noise occurs after reference picture storage, as the reference pictures must be unchanged in order to properly decode the following pictures. Figure 2 shows another receiver end system, in which the noise generator uses as input the decoded picture, and other bitstream information from the video decoder. Figure 2 is compatible with the comfort noise generation described in [4], in which the quantization parameter is the Bitstream information passed from the video decoder to the noise generator.

Figure 1.

Vid D coder

Decoded pictures

To Display

+

Reference picture stores

Noise Generator

Figure 2.

To Display

+

Video Decoder

Decoded pictures

Bitstream information

Noise Generator

Reference picture stores
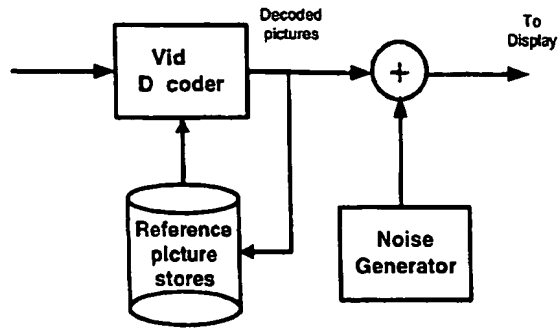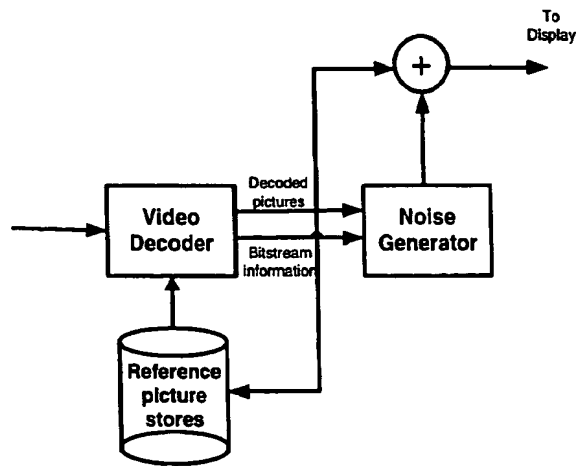
In this invention, the determination of the magnitude of the noise signal to add is based on any of several different factors. Let $N(k, x, y)$ be the added pixel noise signal, $P(k, x, y)$ be the decoded pixel, and $D(k, x, y)$ be the displayed pixel (x, y) of the k-th picture in the video sequence, respectively. The displayed pixel of the picture is the decoded pixel plus the noise signal,

$$D(k, x, y) = P(k, x, y) + N(k, x, y)$$

The visual impact of adding a noise signal to the video sequence, rather than just to a single image, is considered in the determination of the magnitude of the noise signal. The magnitude of additive noise signal for a pixel in a picture is correlated to the value of the additive noise signal of the pixels in the previously displayed picture, e.g., the noise signals are temporally correlated. In an alternative embodiment of the current invention,

the temporal correlation is based on the previously decoded picture, rather than the previously displayed picture.

In an embodiment of the current invention, the added noise signal using temporal correlation, with correlation factor α, $0 \le \alpha \le 1$, is computed as

$$N(k, x, y) = \alpha\, N(k-1, x, y) + (1 - \alpha)\, R(k, x, y) \qquad \text{(Eq. 1)}$$

The random number $R(k, x, y)$ may be generated using any type of random number distribution, for example a Gaussian or Laplacian distribution. The random number generator may be implemented by means of a lookup table. $R(k, x, y)$ may also include spatial correlation, such as that used for example in film grain noise generation.

Because α is fractional, to avoid divisions, Eq. 1 can be simplified,
$$N(k, x, y) = (a * N(k-1, x, y) + (2^b - a)\, R(k, x, y) + 2^{b-1}) >> b \quad \text{(Eq 2)}$$

Figure 3 shows a receiver-end system that includes a noise generator compatible with Eq. 1 or Eq. 2. In Figure 3, the noise signal $N(k, x, y)$ for the k-th picture is stored in the noise picture store.
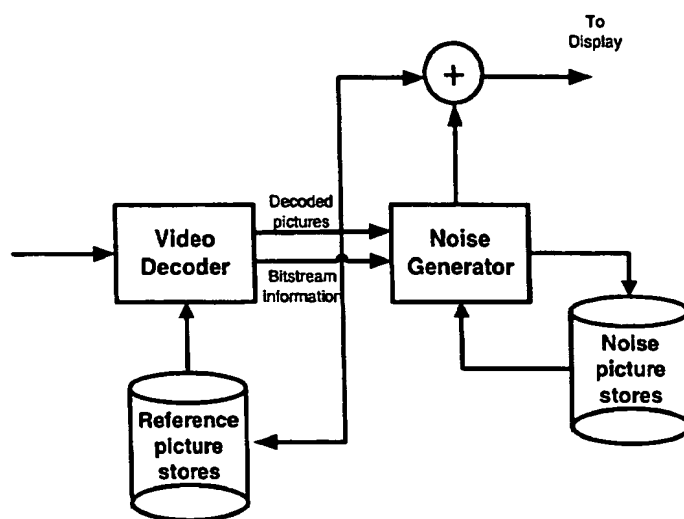

Figure 3.

The system of Figure 3 requires more memory bandwidth than the system of Figure 1, because for each displayed picture the previous displayed picture's noise signal picture must be accessed and the current picture's noise signal picture must be stored.

The system of Eq. 1 and Figure 3 is implementation is an instantiation of a temporal IIR filter. The IIR filter may be generalized by using more filter taps. IIR filters can also generally be approximated using higher order FIR filters, using as many taps, t, as desired.

$$N(k,x,y) = \sum_{i=0}^{t-1} \alpha^{i+1} N(k\text{-}i, x, y) + \alpha^{i}(1\text{-}\alpha) R (k\text{-}i, x, y) \quad (Eq\ 3)$$

An FIR filter approach can be implemented using the system of Figure 2. Only the previous random numbers R, rather than the previous noise, N, is used in an FIR filter approach, so memory bandwidth is reduced.

Possible claims:

1. Add temporally correlated noise as a postprocess following video decoder
2. Claim 1 using a correlation factor alpha
3. Claim 1 with FIR filter implementation

Document made available under the Patent Cooperation Treaty (PCT)

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